THE EFFECT OF MONTMORILLONITIC AND KAOLINITIC CLAYS ON THE FORMATION OF PLATY STRUCTURES

J. B. Peterson

The discovery that certain kinds of crystalline minerals compose a large portion of the clay fraction of soils, together with the development of means for identifying these crystalline materials with specificity, at least by groups, has permitted analysis of soil materials with a discrimination previously impossible (12). The accessibility of these various minerals in fairly pure natural deposits has made possible an extensive study of their properties which has yielded and will continue to yield knowledge of value to soil investigators.

Knowledge of the peculiarities of these minerals, together with knowledge of their relative abundance in a given soil, is useful information, basic to prediction of much of that soil's behavior. With this in mind a study was planned to determine some of the specific effects of a kaolinitic and a montmorillonitic clay upon the morphology of aggregates.

EXPERIMENTAL PROCEDURE AND RESULTS

STRUCTURAL MORPHOLOGY

The clays selected for comparison were a commercial sample of montmorillonite known as “volclay Bentonite”, a Wyoming bentonite from the American Colloidal Company, and a sample of commercial kaolinite from the R. T. Vandervilt Company, Bath, S. C. The exchange capacity of the kaolinite was 203 M.E. and of the volclay montmorillonite, 89.8 M.E. per 100 grams. The volclay, as described by the producers, is 90% montmorillonite and in the natural state is predominantly saturated with Na. Electro-dialyzed portions of these clays were mixed with acid-washed, fine sand in varying proportions of sand and clay. The samples were placed in paper nut cups, stirred well, and subjected to alternate wetting and drying 10 times. Wetting was done by a fine spray from a power atomizer to prevent stratification of the mixture. After each wetting the sample was placed over water in a desiccator for 16 hours before drying at about 40° C.

The samples containing montmorillonite exhibited the swelling and cracking characteristic of that type of clay, whereas the kaolinite samples showed little change other than the development of some small surface cracks. Under the microscope, however, the sand grains of the kaolinite sample were found to be completely coated, whereas those mixed with montmorillonite were almost completely bare (Fig. 1). The samples were impregnated with bakelite lacquer BF-1305 diluted with ether and ethyl alcohol. Vertical sponge-like structure for the montmorillonite.

Thin sections of the samples were prepared, and the petrographic microscope for signs of the clay minerals. Areas of clay, which exhibited birefringence in both the kaolinite and the montmorillonitic samples. They usually appeared as bands around the edges of the grains or as islands in the matrix. These bands and islands were the products of some predominantly isotropic pattern of the clay was evidenced by the fact that each one exhibited uniform and complete extinction positions. Some islands would show complete extinction at one position of the stage. No bands of clay about sand grains or as aggregates seemed different in the two types of clay. In the sponge-like, isotropic structural pattern resulting from sand and montmorillonite, the areas of oriented clay seemed developed as connecting wedges between the grains, or as bands around the grains. In the case of the soil mixture and into a globular mass in the case of the montmorillonite. Where bands of birefringent material encircled quartz grains, the bands were much thinner than those in the montmorillonite. No islands could be found in the oriented areas.

In consideration of the possibility that the larger plates of kaolinite (8, 21) might have with the thin C axis on the vertical in the sample, a second set was prepared to pellets at the moisture equivalent previously described (17). Pellets were from mixtures of one-half clay and of the B horizon of a Tama silt loam. After wetting and drying the pellets containing montmorillonite had developed a distinct pattern of horizontal cracks (Fig. 3), and those containing kaolinite had fallen into small chunks resembling subangular nut structure in the case of the soil mixtures.